CLAIMS

What is claimed is:

1. A semiconductor device, comprising:

a substrate;

a photodiode formed in the substrate, the photodiode receiving photoelectrons in response to photons received by the semiconductor device;

a trench isolation region formed in the substrate, the trench isolation region providing electrical isolation for the photodiode from a plurality of devices formed in the substrate; and

a junction isolation region formed in the substrate, the junction isolation region formed between the photodiode and the trench isolation region, the junction isolation region preventing contact between the photodiode and the trench isolation region.

2. The semiconductor device of claim 1, wherein the junction isolation region is a region doped by a P-type dopant.

3. The semiconductor device of claim 2, wherein the P-type dopant is boron.

4. The semiconductor device of claim 1, wherein the junction isolation region has a thickness in the range of about 0.15 to 0.30 microns.

5. The semiconductor device of claim 1, wherein the substrate is a P-type silicon substrate.

6. The semiconductor device of claim 1, wherein the photodiode is a region doped by an N-type dopant.

7. The semiconductor device of claim 6, wherein the N-type dopant is phosphorous.

8. The semiconductor device of claim 1, further comprising:

a conduction surface implant, the conduction surface implant overlying the photodiode, the conduction surface implant being in contact with a top surface of the substrate to provide electrical contact between the photodiode and the top surface of the substrate.

9. The semiconductor device of claim 8, wherein the conduction surface implant is a region doped by an N-type dopant.

10. The semiconductor device of claim 9, wherein the N-type dopant is phosphorous.

11. The semiconductor device of claim 1, further comprising:

an isolation surface implant, the isolation surface implant overlying the photodiode, the isolation surface implant being in contact with a top surface of the

substrate to provide electrical isolation between the photodiode and the top surface of the substrate.

12. The semiconductor device of claim 11, wherein the isolation surface implant is a region doped by a P-type dopant.

13. The semiconductor device of claim 12, wherein the P-type dopant is boron.

14. The semiconductor device of claim 1, further comprising:

a plurality of photodiodes formed in the substrate, each of the plurality of photodiodes receiving photoelectrons in response to the photons received by the semiconductor device;

a plurality of trench isolation regions formed in the substrate, each of the plurality of trench isolation regions providing electrical isolation for each of the plurality of photodiodes from a plurality of devices in the substrate; and

a plurality of junction isolation regions formed in the substrate, each of the plurality of junction isolation regions formed between each of the plurality of photodiodes and each of the plurality of trench isolation regions to prevent contact between each of the plurality of photodiodes and each of the plurality of trench isolation regions.

15. The semiconductor device of claim 14, wherein the plurality of photodiodes form a solid-state image sensor.

16. The semiconductor device of claim 15, wherein the solid-state image sensor is a complementary metal oxide semiconductor image sensor.

17. The semiconductor device of claim 15, wherein the solid-state image sensor is a charge injection device.

18. The semiconductor device of claim 15, wherein the solid-state image sensor is a charge coupled device.

19. The semiconductor device of claim 16, further comprising a package substrate and an image processor, the solid-state image sensor and the image processor being mounted to the package substrate to form a solid-state image sensor package.

20. The semiconductor device of claim 19, wherein the solid-state image sensor package is used in an imaging device.

21. The semiconductor device of claim 20, wherein the imaging device is a stand-alone digital camera.

22. The semiconductor device of claim 20, wherein the imaging device is a stand-alone digital video camera.

23. The semiconductor device of claim 20, wherein the imaging device is an embedded digital camera.

24. The semiconductor device of claim 20, wherein the imaging device is a personal digital assistant.

25. The semiconductor device of claim 20, wherein the imaging device is a cellular phone.

26. A semiconductor device, comprising:

a substrate;

a photodiode formed in the substrate, the photodiode receiving photoelectrons in response to photons received by the semiconductor device;

a trench isolation region formed in the substrate, the trench isolation region providing electrical isolation for the photodiode from a plurality of devices formed in the substrate;

a junction isolation region formed in the substrate, the junction isolation region formed between the photodiode and the trench isolation region, the junction isolation region preventing contact between the photodiode and the trench isolation region; and

a conduction surface implant, the conduction surface implant overlying the photodiode, the conduction surface implant being in contact with a top surface of the substrate to provide electrical contact between the photodiode and the top surface of the substrate.

27. The semiconductor device of claim 26, wherein the conduction surface implant is a region doped by an N-type dopant.

28. The semiconductor device of claim 27, wherein the N-type dopant is phosphorous.

29. A semiconductor device, comprising:

a substrate;

a photodiode formed in the substrate, the photodiode receiving photoelectrons in response to photons received by the semiconductor device;

a trench isolation region formed in the substrate, the trench isolation region providing electrical isolation for the photodiode from a plurality of devices formed in the substrate;

a junction isolation region formed in the substrate, the junction isolation region formed between the photodiode and the trench isolation region to prevent contact between the photodiode and the trench isolation region; and

an isolation surface implant, the isolation surface implant overlying the photodiode, the isolation surface implant being in contact with a top surface of the substrate to provide electrical isolation between the photodiode and the top surface of the substrate.

30. The semiconductor device of claim 29, wherein the isolation surface implant is a region doped by a P-type dopant.

31. The semiconductor device of claim 29, wherein the P-type dopant is boron.

32. A solid-state image sensor, comprising:

a plurality of photodiodes, each of the plurality of photodiodes receiving photoelectrons in response to the photons received by the solid state-image sensor;

a plurality of trench isolation regions formed in the solid-state image sensor, each of the plurality of trench isolation regions providing electrical isolation for each of the plurality of photodiodes from a plurality of devices in the solid-state image sensor; and

a plurality of junction isolation regions, each of the plurality of junction isolation regions formed between each of the plurality of photodiodes and each of the plurality of trench isolation regions to prevent contact between each of the plurality of photodiodes and each of the plurality of trench isolation regions.

33. The solid-state image sensor of claim 32, wherein the solid-state image sensor is a complementary metal oxide semiconductor image sensor.

34. The solid-state image sensor of claim 33, wherein the solid-state image sensor is a charge injection device.

35. The solid-state image sensor of claim 33, wherein the solid-state image sensor is a charge coupled device.

36. A solid-state image sensor package, comprising:

a package substrate;

an image processor mounted on the package substrate; and

a solid-state image sensor mounted on the package substrate, the solid-state image sensor comprising:

a plurality of photodiodes, each of the plurality of photodiodes receiving photoelectrons in response to the photons received by the solid state-image sensor;

a plurality of trench isolation regions formed in the solid-state image sensor, each of the plurality of trench isolation regions providing electrical isolation for each of the plurality of photodiodes from a plurality of devices in the solid-state image sensor; and

a plurality of junction isolation regions, each of the plurality of junction isolation regions formed between each of the plurality of photodiodes and each of the plurality of trench isolation regions to prevent contact between each of the plurality of photodiodes and each of the plurality of trench isolation regions.

37. The solid-state image sensor package of claim 36, wherein the solid-state image sensor package is in an imaging device.

38. The solid-state image sensor package of claim 37, wherein the imaging device is a stand-alone digital camera.

39. The solid-state image sensor package of claim 37, wherein the imaging device is a stand-alone digital video camera.

40. The solid state image sensor package of claim 37, wherein the imaging device is an embedded digital camera.

41. The solid-state image sensor package of claim 37, wherein the imaging device is a personal digital assistant.

42. The solid-state image sensor package of claim 37, wherein the imaging device is a cellular phone.

43. The solid-state image sensor package of claim 37, wherein the imaging device is a stand alone digital video camera.

44. A method for forming a semiconductor device, comprising:

providing a substrate;

forming a photodiode in the substrate, the photodiode receiving photoelectrons in response to photons received by the semiconductor device;

forming a trench isolation region in the substrate; and

forming a junction isolation region in the substrate, the junction isolation region formed between the photodiode and the trench isolation region so that the photodiode does not contact the trench isolation region.

45. The method of claim 44, wherein the substrate is a P-type silicon substrate.

46. The method of claim 44, wherein the step of forming a photodiode further comprises:

implanting in the substrate an N-type dopant.

47. The method of claim 46, wherein the N-type dopant is phosphorous.

48. The method of claim 46, further comprising:

implanting the N-type dopant with a carrier concentration implant dose in the range of about 1×10^{15} to 1×10^{16} ions/cm^2.

49. The method of claim 44, wherein the step of forming the junction isolation region further comprises:

depositing a P-type dopant, the P-type dopant being boron.

50. The method of claim 49, wherein the P-type dopant is deposited by:

implanting the P-type dopant with a carrier concentration implant dose in the range of about 1×10^{17} to 5×10^{17} ions/cm^2.

51. The method of claim 49, wherein the P-type dopant has a thickness in the range of about 0.15 to 0.30 microns.

52. The method of claim 44, further comprising the step of:

forming a conduction surface implant, the conduction surface implant overlying the photodiode, the conduction surface implant being in contact with a top surface of

the substrate to provide electrical contact between the photodiode and the top surface of the substrate.

53. The method of claim 52, wherein the step of forming the conduction surface implant further comprises:

depositing a N-type dopant.

54. The method of claim 53, wherein the step of depositing the N-type dopant further comprises depositing phosphorous.

55. The method of claim 53, wherein the N-type dopant is deposited by:

implanting the N-type dopant with a carrier concentration implant dose in the range of about 1.5×10^{12} to 3×10^{13} ions/cm^2; and

implanting the N-type dopant at an energy level of about 40 kilo-electron volts.

56. The method of claim 44, further comprising the step of:

forming an insulation surface implant, the isolation surface implant overlying the photodiode, the isolation surface implant being in contact with a top surface of the substrate to provide electrical isolation between the photodiode and the top surface of the substrate.

57. The method of claim 56, wherein the step of forming the insulation surface implant further comprises the steps of:

depositing a P-type dopant.

58. The method of claim 57, wherein the step of depositing the P-type dopant further comprises depositing boron.

59. The method of claim 57, wherein the P-type dopant is deposited by:

implanting the P-type dopant with a carrier concentration implant dose in the range of about 5×10^{12} to 1×10^{13} ions/cm^2; and

implanting the P-type dopant at an energy level of about 40 kilo-electron volts.

60. A method for forming a semiconductor device, comprising:

providing a substrate;

forming a photodiode in the substrate, the photodiode receiving photoelectrons in response to photons received by the semiconductor device;

forming a trench isolation region in the substrate;

forming a junction isolation region in the substrate, the junction isolation region formed between the photodiode and the trench isolation region so that the photodiode does not contact the trench isolation region; and

forming a conduction surface implant, the conduction surface implant overlying the photodiode, the conduction surface implant being in contact with a top surface of the substrate to provide electrical contact between the photodiode and the top surface of the substrate.

61. A method for forming a semiconductor device, comprising:

providing a substrate;

forming a photodiode in the substrate, the photodiode receiving photoelectrons in response to photons received by the semiconductor device;

forming a trench isolation region in the substrate;

forming a junction isolation region in the substrate, the junction isolation region formed between the photodiode and the trench isolation region so that the photodiode does not contact the trench isolation region; and

forming an insulation surface implant, the isolation surface implant overlying the photodiode, the isolation surface implant being in contact with a top surface of the substrate to provide electrical isolation between the photodiode and the top surface of the substrate.

62. A method for forming a semiconductor device, comprising:

providing a substrate;

forming a photodiode in the substrate, the photodiode receiving photoelectrons in response to photons received by the semiconductor device;

forming a trench isolation region in the substrate;

forming a junction isolation region in the substrate, the junction isolation region formed between the photodiode and the trench isolation region so that the photodiode does not contact the trench isolation region;

forming an insulation surface implant, the isolation surface implant overlying the photodiode, the isolation surface implant being in contact with a top surface of the substrate to provide electrical isolation between the photodiode and the top surface of the substrate; and

forming a conduction surface implant, the conduction surface implant overlying the photodiode, the conduction surface implant being in contact with the top surface of the substrate to provide electrical contact between the photodiode and the top surface of the substrate.